# 7.0 Recommendations

The Consent Decree (CD) requires that each Sewershed Study and Plan designate specific improvements or other corrective actions needed to address deficiencies identified during the sewershed evaluation in order to reduce rainfall dependent inflow and infiltration (RDI/I) that contribute to sanitary sewer overflows (SSO's) or combined sewer overflows (CSO's). The Sewershed Study and Plan must also address defects identified during the hydraulic analyses and other deficiencies that contribute to SSO's or CSO's in the Gwynns Falls Sewershed. This section outlines how the data analysis, evaluation and the decision-making criteria were utilized to identify and prioritize improvements within the Gwynns Falls Sewershed.

## 7.1 Decision Making Criteria

As part of the sewershed studies, the City developed a protocol that provides a framework for a continuous rehabilitation strategy of all collection system components based on both criticality (consequence of failure) and condition (probability of failure). Assets whose failure can have large impacts on the community and the environment and whose condition is the poorest will receive a higher criticality rating and will receive attention sooner. Assets that receive a lower criticality rating will receive some level of continued monitoring but no immediate action or rehabilitation at this time.

The prioritization process consists of five steps illustrated below.


*Step 1:*
Identify the condition and criticality factors that will be used to assess the sewer system. These factors have been identified and include proximity to human population, to bodies of water, to forests, and to wildlife habitat that could potentially be affected by a sewer system failure.

*Step 2:*
Collect data that will be used to evaluate each factor including CCTV inspection data, manhole inspection data, pumping station inspection data, GIS data, results of hydraulic modeling, and sewer complaint data.

*Step 3:*
Assign different levels to each factor so that pipes, manholes, and pumping stations can be differentiated in terms of their condition or criticality.

*Step 4:*
Assign a condition and criticality rating for each pipe, manhole and pumping station. The ratings are assigned by using the level assigned to each factor and the relative importance of each factor.

*Step 5:*
Use the ratings to prioritize the system and determine short-term and long-term rehabilitation projects.

For each category, multiple factors were used to measure the condition and criticality of every asset. Table 7.1.1 below lists the condition and criticality categories and factors that were considered.

**Table 7.1.1 - Condition and Criticality Factors**

| Criticality Category | Criticality Factor |
|---|---|
| Quantity of Flow Conveyed | Pipe Diameter<br>Pump Station Capacity |
| Transportation / Urban Impact | Proximity to Historic Areas<br>Proximity to Community Areas (Parks, Schools, Etc.)<br>Traffic Conditions<br>Proximity to Railroad Easements |
| Environmental Impact | Proximity to Forested Areas<br>Proximity to Waterways / Streams<br>Proximity to Wetlands |
| Public Health Impact | Population Density<br>Proximity to Floodplains<br>SCADA / Warning Systems |
| Ease of Emergency Repair | Accessibility<br>Ability to Re-route Flow<br>Proximity to City Conduits<br>Building Encroachment<br>System Redundancy<br>Emergency Power<br>Ability to Bypass Flow<br>Pipe Depth |
| **Condition Category** | **Condition Factors** |
| Structural Condition | Structural Pipe Rating<br>Manhole Inspection Rating |
| Maintenance Frequency | O&M Pipe Rating<br>Number of SSO's or CSO's<br>Known Maintenance Issues<br>Documented RDI/I Rates |
| Capacity | Need for Additional Capacity |

Each condition and criticality factor is assigned a rating from 1 to 5. The purpose of assigning ratings to each condition and criticality factor is to differentiate sewer pipes, manholes, and pumping stations in terms of the consequences and probability of their failure.

The rating assigned increases as the consequence of failure or probability of failure increases. For example, a break in a 24-inch diameter interceptor sewer can result in more wastewater being released than a break in an 8-inch diameter collector sewer. Therefore, the larger diameter pipe has a higher criticality rating based on the amount of flow being conveyed. The 24-inch diameter interceptor sewer would be assigned a higher rating (5) for the 'Quantity of Flow Conveyed' criticality factor and the 8-inch diameter collector sewer would be assigned a lower rating (1) for the same factor.

After a rating of 1 through 5 is assigned, an overall criticality rating and an overall condition rating is calculated for each system component. The criticality rating is calculated as the highest individual level assigned to any of the criticality factors multiplied by a relative importance value. The condition rating is equal to the highest individual NASSCO PACP or MACP rating assigned to any of the condition factors. The

relative importance value for the criticality rating is the weight, expressed as a percentage, applied to each criticality factor to calculate an overall rating. The relative importance values are the same for each collection system component and are presented in Table 7.1.2.

**Table 7.1.2 - Criticality Factor Relative Importance Values**

| Criticality Factors | Relative Importance Value |
|---|---|
| Quantity of Flow Conveyed | 30% |
| Transportation/Urban Impact | 15% |
| Environmental Impact | 20% |
| Public Health Impact | 15% |
| Ease of Emergency Repair | 20% |
| **Total** | **100%** |

The final assessment culminates in a rating of 1 through 5 for criticality and utilizing NASSCO's MACP or PACP, a 1 through 5 rating for condition, which determines priorities for repairs or continuous condition assessment or monitoring. This approach allows the City to focus their available resources and funding on the most immediate system repair needs. Figure 7.1.1 is a matrix showing the recommended course of action for each sewer system component based on the combination of condition and criticality. The vertical 1 through 5 scale rates the asset's condition and the horizontal 1 through 5 scale is a rating for an asset's criticality within the collection system.

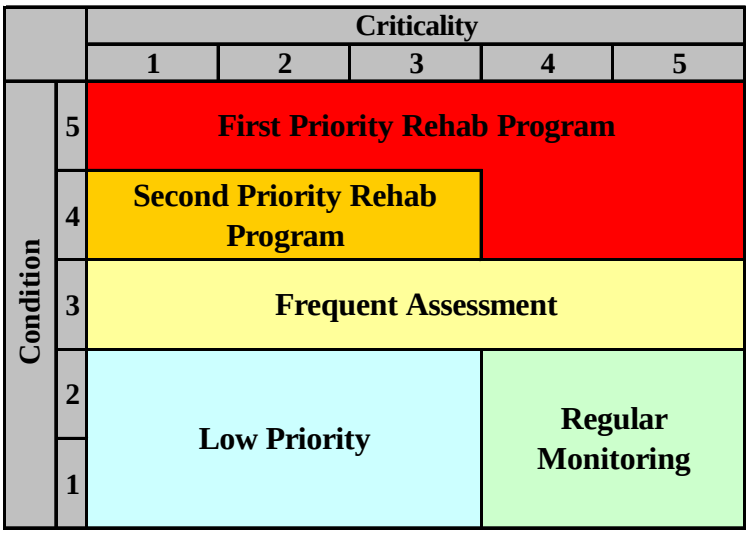


**Figure 7.1.1 – Condition/Criticality Matrix**

Each of the recommended courses of action is briefly described in more detail below. The specific improvement projects and/or other corrective actions will vary based on the type of collection system component (gravity sewer, force main, manhole, or pumping station) affected.

**First Priority Rehabilitation Program**

Assets that receive a condition rating of 5 regardless of criticality, and assets that receive a condition rating of 4 and criticality rating of 4 and 5 are placed at the highest

priority for rehabilitation, repair or replacement. These assets lack hydraulic capacity, contribute to system inflow and infiltration (I/I) and/or are likely to fail in the near future. These assets have the highest potential for SSO's or could create a major disruption in service and potentially impact the environment and/or public health if not addressed.

**Second Priority Rehabilitation Program**
Assets that receive a condition rating of 4 and criticality rating of 1, 2, or 3 will be given second priority in the rehabilitation program. These assets contribute to system I/I, and are likely to continue to deteriorate and to require attention in the foreseeable future.

**Frequent Assessment**
Assets that are in fair physical condition (PACP/MACP condition rating of 3), should have their condition assessed frequently, every 2 to 3 years regardless of the criticality rating. The purpose of frequent assessment is to check if the condition has deteriorated to a point that the asset would need to be moved to a higher priority.

**Regular Monitoring**
The assets in the regular monitoring category are typically in serviceable condition (PACP/MACP condition rating of 1 or 2), but received a high criticality rating of 4 or 5. These assets should be checked every 3 to 5 years.

**Low Priority**
The low priority category includes assets that are believed to be in good condition (PACP/MACP condition rating of 1 to 2), and received a lower criticality rating of 1 through 3. The assets in this category will receive some level of inspection (once every 5 to 10 years) to verify that their conditions are not continuing to deteriorate.

## 7.2 Proposed Improvements

The interrelationship between the City's sewersheds and/or surrounding Counties, known as "boundary" conditions, must be understood and carefully considered before significant hydraulic repairs are completed. The Gwynns Falls Sewershed contains two structures capable of allowing flow to exit the sewershed onto neighboring sewersheds. Specifically, the Baltimore Street Diversion was designed to allow flow to be diverted from the Gwynns Falls Sewershed to the High Level Sewershed, which discharges into the Outfall sewershed. Similarly, the Primson Avenue Diversion allows flow contributions from the Gwynns Falls Sewershed to discharge into the Low Level sewershed, which discharges into the Outfall Sewershed. However, during normal system operation under both baseline and future conditions scenarios, no flow is diverted at these structures to the High Level or Low Level Sewersheds. Therefore, representation of the boundary conditions between the Gwynns Falls, High Level and Low Level Sewersheds was not appropriate under baseline and future conditions scenarios.

A strong interconnection exists between the Gwynns Falls Sewershed and the surrounding counties. Specifically, the City of Baltimore Gwynns Falls Sewershed receives sanitary flow contributions from Baltimore County at the City/County border, and from Anne Arundel, Howard, and Baltimore Counties at the South West Diversion via the Patapsco pump station pressure main.

These flow interconnections with neighboring counties are hydraulically dependant conditions that create conditions that must be defined and considered for hydraulic modeling. Ultimately, the collection system of the Gwynns Falls Sewershed, contributing

counties, and receiving sewersheds should be modeled as one to obtain a better understanding of the system's dynamic operation and, therefore, allow for the development of hydraulic recommendations that can more accurately represent the behavior of contributing sewersheds to the Gwynns Falls Sewershed.

The City has begun development of a model that will result in system-wide modeling between City sewersheds, to be refined and improved as the individual sewershed studies complete calibration of their respective sewershed models. This Plan provides recommended improvements to be implemented by the City in accordance with a proposed schedule. However, the Plan should not be considered final and may require amendment as necessary once the system-wide hydraulic model is completed and system-wide simulations are performed. System-wide simulations may alter the recommendations identified by an individual Sewershed Study and Plan. Furthermore, the contributions from tributary counties to the Gwynns Falls collection system require not only a system-wide model but also a region-wide model which includes the surrounding counties. This regional model can be used to better determine the hydraulic recommendations this Plan has developed, in particular those at the specified boundary conditions.

Once the sewer system improvement projects and/or other corrective actions required to address structural deficiencies were identified and ranked based on the criticality and condition ratings, assets that received a condition rating of 5, regardless of criticality, were included in a "First Priority" corrective action plan. Assets that had a condition rating of 4 and a criticality rating of 4 or 5 were also included in a "First Priority" corrective action plan. Assets that received a condition rating of 4, but were not considered to be as critical (3 or less) were included in the "Second Priority" corrective action plan.

Asset prioritization was developed with consideration that all proposed improvement projects required to eliminate SSO's must be completed before January 1, 2016 as stipulated by the CD. These assets included First and Second Priority manholes and sanitary sewers, identified SSO structures, and recommended hydraulic improvements to the collection system. These proposed improvement projects are as follows:

### 7.2.1 Sanitary Sewer Overflow Structure Identification and Elimination

As a requirement of the City's CD, the Sewershed Study and Plan must identify suspected SSO structures. Investigations completed in support of this report have identified three (3) suspected SSO structures in the Gwynns Falls sewershed. The structures and their locations are:

- S06II1001MH located in an easement west of the intersection of Parkview and Chrysler Avenues. This overflow has been numbered as SSO #141
- S09A__028MH located at 810 North Hilton Street. This overflow has been numbered as SSO #142
- S09A__017MH located east of 810 North Hilton Street. This overflow has been numbered as SSO #143

### 7.2.2 Structural Deficiencies Identified

**Proposed Manhole Improvements (Condition Rating Grade 4 & 5):**
Table 7.2.2.1 shows a listing of all manholes inspected within the Gwynns Falls Sewershed based on condition ratings and further isolated into sub-sewersheds. Manhole recommendations were based on a review of the field inspection reports. Table 7.2.2.2 quantifies the number of manholes that received a MACP condition rating score of 4 or 5 and are recommended for repairs. These manholes are further separated by sub-sewersheds for contract scheduling.

Table 7.2.2.1 - Condition Ratings - Manholes by Sub-Sewershed

| | | Gwynns Falls Sub-Sewershed - Manhole Condition Ratings (1 through 5) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DR | | FP | | GF | | MC | | PA | | PM | | SD | | WB | |
| Overall Rating | Totals | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| 1 - Overall Rating | 681 | 51 | 14% | 72 | 13% | 199 | 16% | 226 | 26% | 17 | 31% | 77 | 9% | 1 | 33% | 29 | 11% |
| 2 - Overall Rating | 1928 | 159 | 43% | 249 | 44% | 596 | 49% | 369 | 43% | 22 | 40% | 379 | 46% | 2 | 67% | 124 | 48% |
| 3 - Overall Rating | 1447 | 146 | 40% | 229 | 40% | 377 | 31% | 228 | 26% | 12 | 22% | 341 | 41% | 0 | 0% | 92 | 36% |
| 4 - Overall Rating | 157 | 11 | 3% | 16 | 3% | 45 | 4% | 39 | 5% | 3 | 5% | 28 | 3% | 0 | 0% | 11 | 4% |
| 5 - Overall Rating | 17 | 0 | 0% | 2 | 0% | 9 | 1% | 2 | 0% | 1 | 2% | 2 | 0% | 0 | 0% | 1 | 0% |
| MH's Inspected | 4230 | 367 | | 568 | | 1226 | | 864 | | 55 | | 827 | | 3 | | 257 | |

Table 7.2.2.2 - Manhole MACP Condition Ratings 4 & 5

| | | Gwynns Falls Sub-Sewershed - Manhole Condition Ratings (4 and 5) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DR | | FP | | GF | | MC | | PA | | PM | | SD | | WB | |
| Overall Rating | Totals | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| 4 - Overall Rating | 138 | 12 | 100% | 14 | 88% | 48 | 83% | 36 | 92% | 3 | 75% | 21 | 95% | 0 | 0% | 11 | 92% |
| 5 - Overall Rating | 16 | 0 | 0% | 2 | 13% | 10 | 17% | 3 | 8% | 1 | 25% | 1 | 5% | 0 | 0% | 1 | 8% |
| MH's w/ 4&5 Rating Inspected | 154 | 12 | | 16 | | 58 | | 39 | | 4 | | 22 | | 0 | | 12 | |

**Proposed Siphon Vault Improvements:**
The sewershed study identified structure S03GG_004MH, the upstream vault to one of the three-barrel siphons on the main Gwynns Falls interceptor, as requiring emergency rehabilitation. The criticality of this structure in the system's operation led to the inclusion of an independent project for its rehabilitation. This project will involve the rehabilitation of the siphon vault as well as the heavy cleaning of 400 lf of 24 inch pressure sewer.

**Proposed Sanitary Sewer Improvements:**
Table 7.2.3 shows the length of the sanitary sewers located within the Gwynns Falls Sewershed that were ranked as First and/or Second Priority assets requiring repair and any defects recommended for repair, regardless of overall rating. All First and Second Priority sewers are recommended for repairs. These sewers are further divided into sub-sewersheds for contract scheduling.

Table 7.2.3 - Sanitary Sewers Ratings in Gwynns Falls by Sub-Sewershed

| | | Gwynns Falls Sub-Sewershed - Sewer Condition Ratings (1 through5) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DR | | FP | | GF | | MC | | PA | | PM | | SD | | WB | |
| Overall Rating | Totals | LF | % | LF | % | LF | % | LF | % | LF | % | LF | % | LF | % | LF | % |
| 1 - Overall Rating | 865,734.00 | 62,251 | 1 | 119,248 | 1 | 268,210 | 1 | 180,740 | 1 | 11,509 | 1 | 160,438 | 1 | 13,407 | 1 | 49,931 | 1 |
| 2 - Overall Rating | 104,545.57 | 4,340 | 0 | 24,314 | 0 | 30,671 | 0 | 15,331 | 0 | 350 | 0 | 25,427 | 0 | - | - | 4,113 | 0 |
| 3 - Overall Rating | 20,089.61 | 728 | 0 | 6,558 | 0 | 2,962 | 0 | 2,805 | 0 | - | - | 6,751 | 0 | - | - | 286 | 0 |
| 4/5 - Overall Rating | 4,796.32 | - | - | 1,989 | 0 | 1,470 | 0 | 834 | 0 | 503 | 0 | - | - | - | - | - | - |
| Total LF | 995,165.50 | 67,319 | | 152,109 | | 303,313 | | 199,710 | | 12,362 | | 192,616 | | 13,407 | | 54,330 | |

**Maidens Choice Pressure Sewer Inspection**
The Maidens Choice Pressure Sewer, a 5,100-lf 27-inch sewer alignment that connects the Maidens Choice Sub-Sewershed to the South West Diversion, was

identified as requiring further inspection as part of the sewershed study. The inspection of the pressure line was not completed due to operational and pipe size constraints that limited the inspection technologies available at the time the field investigation phase of the study took place. Therefore, a subsequent project is included for the future inspection of the Maidens Choice Pressure Sewer. In the planning of this project, it was assumed that existing valves at the Primson Avenue diversion chamber and the blow-off valves along the pressure sewer's alignment would be used to dewater the pressure sewer.

### 7.2.3 Proposed Gwynns Falls Collection System Hydraulic Improvements

Within the Gwynns Falls Sewershed, the Powder Mill, Forrest Park, Dead Run, Gwynns Falls, and Maidens Choice sub-sewersheds require hydraulic improvements to eliminate sanitary sewer overflows when conveying sanitary sewer flow characteristic of a precipitation event with duration of 24 hours and an average return interval of 2 years. These hydraulic improvements include replacement of existing sewers with larger pipes to increase hydraulic capacity to effectively convey peak wet-weather flows, sewer pressurization achieved by sealing specific manholes, off-line flow equalization storage achieved by installing storage tanks at specific locations and of specific dimensions to store the necessary flow volume to impede overflows, and sewer rehabilitation by cured in place pipe lining (CIPPL) and manhole sealing to reduce RDI/I and peak wet-weather flows that may result in sewer overflows.

Map 7.3.1, attached to this document, details the locations of the following projects described on a sub-sewershed basis.

**Powder Mill**
URS recommends that approximately 773-feet of the Powder Mill interceptor be upsized from 27 to 36-inches in diameter from the intersection of Liberty Heights Avenue and West Northern Parkway to the City-County border. In addition, 276-feet of an isolated sewer line should be upsized from 12 to 18 inches in diameter on Bowers Avenue.

URS also recommends that 9 manholes be reconstructed within the sewers recommended for upgrade and that 7 manholes be sealed at specific locations to pressurize sewer flow during system stressing rain events. Please refer to Map 7.3.1 for specific details.

**Forrest Park**
URS recommends that 1,173-feet of the Forrest Park interceptor be upsized from 21 to 24-inches in diameter from the intersection of Wentworth and Hillsdale Roads to 2905 Hillsdale Road. Additionally, 7 manholes should be reconstructed on the sewers recommended for upgrade within the Forrest Park sub-sewershed and one manhole should be sealed at the intersection of Wentworth and Hillsdale Roads in order to pressurize sewer flow during system stressing events.

Moreover, URS also recommends that 66,118-feet of sewer pipe ranging from 8 to 24-inch diameter and 312 manholes be rehabilitated by CIPPL in basins GF26 and GF27 to reduce the amount of infiltration entering the system. Please refer to Map 7.3.1 for specific details.

**Dead Run**
Along the tributary sewers to the main Dead Run interceptors, approximately 698-feet of sewers should be upsized from 10 to 12-inches from the intersection of Briarclift Road and Cooks Lane through the intersection of Briarclift Road and Nottingham Road. URS also recommends that approximately 710-feet of pipe along Briarclift Road be upsized from 10 to 15-inches in diameter. Additionally, it is recommended that 513-feet of sewer pipes be upsized from 8 to 12-inches in diameter beginning and the intersection of Briarclift Road and Brookwood Road. Approximately 3,243-feet of sewer pipe at the intersection of Briarclift Road and Winans Way to where the Briarclift Branch connects with the Dead Run interceptor is also recommended to be upsized from 10 and 15-inches to 12 and 18-inches in diameter, respectively.

Along the main Dead Run interceptors, URS recommends that approximately 3,593-feet of sewer pipe be upsized from 24 to 27-inches in diameter from manhole S02CC_006MH to where the Dead Run interceptor connects to the main Gwynns Falls interceptor. Approximately 1,449-feet of sewer pipes is also recommended to be upsized from 18 to 24-inches in diameter along North Franklintown Road between manholes S01EE_007MH and S03EE_009MH. Additionally, URS recommends that 54 manholes be reconstructed on the sewers recommended for upgrade within the Dead Run sub-sewershed and that 4 of the manholes to be reconstructed are also sealed to allow for pressurized flow during rain events.

**Maidens Choice**
URS recommends that sewer pipes be upgraded from 8 and 24-inches to between 12 and 36-inches in diameter at select locations in the sub-sewershed.

644-feet of the sewer along Greenwich Avenue from Charing Cross Road to Aldershot Road should also be upsized from 8-inches to 12-inches. Our recommendations also include the upsizing of 86-feet of sewer pipe from 15 to 18-inch near the intersection of Mallow Hill Road and Frederick Avenue. Additionally, URS recommends that the 10-foot pipe connecting manholes S09S__009MH and S09S__028MH be upsized from a 24 to 36-inch in diameter. 11 manholes should also be reconstructed due to sewer pipe upsizing and that one structure among these, and three others within the sub-sewershed, be sealed to allow pressurized flow during system stressing rain events.

URS also recommends that two storage facilities be constructed in the Maidens Choice sub-sewershed. The first storage facility, 1.2 MGal in size, is to be located at the intersection of South Beechfield Avenue and Stafford Street, and a new 222-feet 36-inch pipe should be constructed to connect the storage facility to manhole S01O__018MH. The second storage facility, 1.25 MGal in size, is to be located off of the intersection of Parkton Street and Yale Avenue, and a 138-feet 24-inch pipe should be constructed to connect the storage facility to manhole S05Q__024MH to allow for transport of peak sewer flows from the collection system and for the subsequent release of attenuated flows back to the collection system.

The hydraulic recommendations within the Maidens Choice sub-sewershed also include the complete rehabilitation of 32,607-feet of sewer pipe ranging from 8 to 18-inches in diameter in basins GF01A and GF01B. 169 manholes should also be rehabilitated in these two basins to reduce the amount of infiltration entering

the Maidens Choice sub-sewershed sub-sewershed. Please refer to Map 7.3.1 for specific details.

**Gwynns Falls**
URS recommends that approximately 1,359-feet of 8-inch sewer pipe be upsized to 12-inches along Edmondson Avenue and Hilton Parkway. 1,344-feet of sewer pipe near W Baltimore St should also be upsized from 18 to 21-inch starting at manhole S11K__024MH to manhole S13I__012MH. Additionally, URS recommends the reconstruction of 21 manholes on the upsized pipes and that one structure among these, and three others within the sub-sewershed, be sealed to allow pressurized flow during system stressing rain events. Please refer to Map 7.3.1 for specific details.

## 7.3 Proposed Improvement Implementation Schedule

An implementation schedule for completion of the proposed SSO elimination and sewer system improvements has been developed as part of this project based on project cost, anticipated project duration, available manpower, and materials. In all cases, projects have been scheduled to minimize public impact and coordinated with other similar projects being conducted throughout the City. The implementation schedule was developed with the consideration that all proposed improvements must be completed before January 1, 2016 as stipulated by the CD. The following schedules have been developed providing time to successfully complete the required work.

**Manhole Rehabilitation:**
The schedule provided in Table 7.3.1 represents a reasonable duration required for the City to select an engineering consultant to prepare the required design documents, advertise the project, select a contractor to complete the required repairs and have the effectiveness of the repairs evaluated.

Table 7.3.1 - Manhole Rehabilitation Implementation Schedule

| Paragraph 9 Project ID | Project Title | Project Description | CD Milestone Dates | | |
|---|---|---|---|---|---|
| | | | Advertise Project | Construction Complete | Evaluation Phase Completion |
| 1 | Sanitary Sewer Manhole Rehabilitation | Completion of Manhole Rehabilitation/Replacement Projects Throughout the Gwynns Falls Sewershed | 5/4/2012 | 8/1/2013 | 1/29/2014 |
| 2 | Siphon Vault Rehabilitation | Completion Siphon Vault Rehabilitation & Cleaning | 3/15/2014 | 6/15/2015 | 12/29/2015 |

**Sanitary Sewer Rehabilitation and Further Inspection:**
The schedule provided in Table 7.3.2 represents a reasonable duration required for the City to select an engineering consultant to complete the required design documents, advertise the project, select a contractor to complete the work and have the effectiveness evaluated.

Table 7.3.2 - Sanitary Sewer Rehabilitation Implementation Schedule (First & Second Priority) and Further Inspection

| Paragraph 9 Project ID | Project Title | Project Description | CD Milestone Dates | | |
|---|---|---|---|---|---|
| | | | Advertise Project | Construction Complete | Evaluation Phase Completion |
| 1 | First Priority Rehabilitation | CIPP, Point Repairs, and Combination CIPP/Point Repairs for First Priority | 5/4/2012 | 8/1/2013 | 1/30/2014 |
| 1A | First Priority Rehabilitation | CIPP, Point Repairs, and Combination CIPP/Point Repairs for Second Priority | 8/6/2012 | 11/3/2013 | 5/2/2014 |
| 2 | Maidens Choice Pressure Sewer Inspection | Dewatering and Inspection of the Pressure Sewer | 3/15/2014 | 6/15/2015 | 12/29/2015 |

**Hydraulic Improvements:**

The schedule provided in Table 7.3.3 represents a reasonable duration for the City to select an engineering consultant to complete the required design documents, advertise the project, select a contractor, implement the required improvements and evaluate the effectiveness of the repairs.

Table 7.3.3 - Hydraulic Improvement Schedule

| Paragraph 9 Project ID | Project Title | Project Description | CD Milestone Dates | | |
|---|---|---|---|---|---|
| | | | Advertise Project | Construction Complete | Evaluation Phase Completion |
| 1 | Powder Mill Interceptor Sewer Replacement | Upsize of the Powder Mill Interceptor from 27 to 36-inches in Diameter | 10/1/2012 | 12/31/2013 | 7/2/2014 |
| 2 | Powder Mill Sewer Replacement | Miscellaneous Sewer Replacement from 12 to 18-inches in Diameter | 7/19/2012 | 10/15/2013 | 4/15/2014 |
| 3 | Forest Park Interceptor Sewer Replacement | Upsize of the Forrest Park Internceptor from 21 to 24-inches in Diameter | 9/30/2012 | 12/28/2013 | 6/27/2014 |
| 4 | Forest Park Sewer Rehabilitation | Rehabilitation Sewers to Reduce Infiltration | 10/1/2012 | 1/2/2014 | 7/3/2014 |
| 5 | Dead Run Interceptor Sewer Replacement | Upsize of the Dead Run Interceptor to 27-inches in Diameter | 1/1/2013 | 4/1/2014 | 10/2/2014 |
| 6 | Dead Run Sewer Replacement | Miscellaneous 12- to 18-Inch Sewer Replacement | 1/1/2013 | 4/1/2014 | 10/1/2014 |
| 7 | Gwynns Falls Sewer Replacement | Miscellaneous 12- to 21-Inch Sewer Replacement | 4/2/2013 | 7/1/2014 | 12/31/2014 |
| 8 | Maidens Choice Sewer Replacement | Miscellaneous 12- to 36-Inch Sewer Replacement | 4/2/2013 | 7/1/2014 | 12/31/2014 |
| 9 | Maidens Choise Off-Line Storage | 1.2 MG Combined Off-Line Storage of Two Tanks | 4/1/2013 | 6/27/2015 | 9/25/2015 |
| 10 | Maidens Choise Off-Line Storage | 1.25 MG Combined Off-Line Storage of Two Tanks | 4/1/2013 | 6/27/2015 | 9/25/2015 |

## 7.4 Estimated Costs of the Proposed Improvement Projects

To characterize expected costs for the collection system improvements necessary in the Gwynns Falls Sewershed, the City completed a review of information compiled from prior City projects for various types of repairs, rehabilitation and replacement of manholes and sanitary sewers. In addition, costs were also collected from Means' and a national study of unit costs for a wide variety of repair/replacement options in locations throughout the United States. Once compiled, the information was reviewed, compared and normalized for use in preparing reasonable estimates for the City's sewershed improvements.

The unit prices developed by the City represent average unit costs that were derived from the sources identified. Some significant variability was, however, noted when comparing the unit costs developed by contractors bidding on the same project, and there was considerable variability when comparing these documented unit costs with other similar types of repair techniques employed on different projects. Such unit cost variability reflects both the site specific nature of each project as well as the normal variability typically associated with varying markets, project time constraints and other

construction related considerations. While site specific attributes are understood to have an impact on final costs for a given rehabilitation/repair/replacement effort, it is the City's intent to ensure that all of the sewersheds use the same baseline cost assumptions for consistency and planning purposes. These fully-loaded costs are an attempt to capture all relevant costs associated with a construction project such as mobilization, bypass pumping, site/paving restoration, and repair of other utilities, which can add significantly to the cost, but are typically required to complete the overall project.
The recommendations for improvements to the South West Diversion (SWD) are not included within the Plan's cost estimate. Although the recorded observations were reported in Section 4 - Sewer System Evaluation Study, the recommendations for improvements, and their respective cost estimate, are to be provided to the City by the three on-going SWD rehabilitation and realignment projects SC866, SC867, and SC875. Furthermore, all observed structural and operational deficiencies within the SWD collected by the Gwynns Falls Sewershed project were transmitted to the appropriate consulting firms and client contacts.

### 7.4.1 Estimated Improvement Budget

The following section outlines the proposed costs utilizing fully-loaded cost data required to implement the First and Second Priority collection system improvements.

**Estimated Manhole Rehabilitation Budget:**
Table 7.4.1 is the estimated 2008 costs required to rehabilitate all First and Second Priority sanitary sewer manholes identified in the Gwynns Falls collection system.

Table 7.4.1 - Estimated Manhole Rehabilitation and Replacement Improvement Budget

| First Priority Manholes | | | | |
|---|---|---|---|---|
| **Item** | **Method** | **Unit Cost** | **Quantity (ea.)** | **Cost** |
| Manhole | Rehabilitation / Replacement | $3,719.00 | 17 | $63,223.00 |
| | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $26,553.66 |
| | | | Total - First Priority Manholes: | $89,776.66 |
| **Second Priority Manholes** | | | | |
| **Item** | **Method** | **Unit Cost** | **Quantity (ea.)** | **Cost** |
| Manhole | Rehabilitation / Replacement | $3,719.00 | 56 | $208,264.00 |
| | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $87,470.88 |
| | | | Total - Second Priority Manholes: | $295,734.88 |

| Siphon Vault Rehabilitation | | | | |
|---|---|---|---|---|
| **Item** | **Unit Cost** | | **Quantity (ea.)** | **Cost** |
| Flow Control | $55,000.00 | EA | 1.00 | $55,000.00 |
| Structure Rehabilitation | $74,380.00 | EA | 1 | $74,380.00 |
| Siphon Cleaning | $15.00 | /LF | 400 | $6,000.00 |
| | | | Subtotal: | $135,380.00 |
| | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $56,859.60 |
| | | | **Total:** | **$192,239.60** |
| | | | **Total Estimated First and Second Priority Manholes:** | **$577,751.14** |

**Estimated Sanitary Sewer Rehabilitation Budget:**

Table 7.4.2 presents the estimated 2008 costs required to rehabilitate all First and Second Priority sanitary sewers identified in the Gwynns Falls collection system.

Table 7.4.2 - Estimated Sewer Rehabilitation and Replacement Improvement Budget

| First Priority Sewers | | | | | |
|---|---|---|---|---|---|
| **Sewer Size** | **Unit Cost (s)** | | **Quantity (LF)** | | **Cost** |
| **CIPP Lining** | | | | | |
| 8" Sewer Lining: | $45.00 | | 2,602.6 | | $117,117.00 |
| 8+" - 12" Sewer Lining: | $64.00 | | 749.0 | | $47,936.99 |
| 12+" - 18" Sewer Lining: | $87.00 | | 221.4 | | $19,264.76 |
| 24+" - 30" Sewer Lining: | $169.00 | | 352.3 | | $59,540.94 |
| Total CIPP Lining: | | | 3,925.4 | | $243,859.68 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $102,421.07 |
| **Total First Priority CIPP Lining:** | | | | | **$346,280.75** |
| **Point Repairs (assume 10' repairs)** | | | | | |
| 8" Point Repair: | $378.00 | | 450.0 | | $170,100.00 |
| 8+" - 12" Point Repairs: | $378.00 | | 40.0 | | $15,120.00 |
| 12+" - 18" Point Repairs: | $378.00 | | 50.0 | | $18,900.00 |
| 24+" - 30" Point Repairs: | $841.00 | | 10.0 | | $8,410.00 |
| Total Point Repairs: | | | 550.0 | | $212,530.00 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $89,262.60 |
| **Total First Priority Point Repairs:** | | | | | **$301,792.60** |
| **Point Repairs & CIPP Lining** | | | | | |
| | Point Repair | CIPP | Point Repair | CIPP | |
| 8" Point Repair / CIPP: | $378.00 | $45.00 | 40.0 | 769.9 | $49,764.22 |
| Total Point Repairs & CIPP Lining: | | | 40.0 | 769.9 | $49,764.22 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $20,900.97 |
| **Total First Priority Point Repairs & CIPP Lining:** | | | | | **$70,665.20** |
| **Replacement (assume > 10' repairs)** | | | | | |
| 8" Replacement: | $270.00 | | 290.0 | | $78,300.00 |
| Total Replacements: | | | 290.0 | | $78,300.00 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $32,886.00 |
| **Total First Priority Replacement:** | | | | | **$111,186.00** |
| **Replacement & CIPP Lining** | | | | | |
| | Replacement | CIPP | Replacement | CIPP | |
| 8" Replacement / CIPP: | $270.00 | $45.00 | 62.0 | 750.8 | $50,525.95 |
| Total Replacement & CIPP Lining: | | | 62.0 | 750.8 | $50,525.95 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $21,220.90 |
| **Total First Priority Replacement & CIPP Lining:** | | | | | **$71,746.84** |
| **Total Estimated First Priority Sewer:** | | | | | **$901,671.39** |

| Second Priority Sewers | | | | | |
|---|---|---|---|---|---|
| **Sewer Size** | **Unit Cost (s)** | | **Quantity (LF)** | | **Cost** |
| **CIPP Lining** | | | | | |
| 8" Sewer Lining: | $45.00 | | 9,866.2 | | $443,980.86 |
| 8+" - 12" Sewer Lining: | $64.00 | | 1,546.2 | | $98,955.02 |
| 12+" - 18" Sewer Lining: | $87.00 | | 195.4 | | $16,996.88 |
| Total CIPP Lining: | | | 11,607.8 | | $559,932.76 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $235,171.76 |
| **Total Second Priority CIPP Lining:** | | | | | **$795,104.53** |
| **Point Repairs (assume 10' repairs)** | | | | | |
| 8" Point Repair: | $378.00 | | 2,390.0 | | $903,420.00 |
| 8+" - 12" Point Repairs: | $378.00 | | 90.0 | | $34,020.00 |
| 12+" - 18" Point Repairs: | $378.00 | | 10.0 | | $3,780.00 |
| Total Point Repairs: | | | 2,490.0 | | $941,220.00 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $395,312.40 |
| **Total Second Priority Point Repairs:** | | | | | **$1,336,532.40** |
| **Point Repairs & CIPP Lining** | | | | | |
| | Point Repair | CIPP | Point Repair | CIPP | |
| 8" Point Repair / CIPP: | $378.00 | $45.00 | 150.0 | 72 | $59,940.00 |
| Total Point Repairs & CIPP Lining: | | | 150.0 | 72 | $59,940.00 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $25,174.80 |
| **Total Second Priority Point Repairs & CIPP Lining:** | | | | | **$85,114.80** |
| **Replacement (assume > 10' repairs)** | | | | | |
| 8" Replacement: | $309.12 | | 2,730.4 | | $844,034.64 |
| 8+" - 12" Replacement: | $566.73 | | 253.8 | | $143,852.24 |
| 12+" - 18" Replacement: | $669.77 | | 136.0 | | $91,088.24 |
| Total Replacements: | | | 3,120.2 | | $1,078,975.13 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $453,169.55 |
| **Total Second Priority Replacement:** | | | | | **$1,532,144.68** |
| **Replacement & CIPP Lining** | | | | | |
| | Replacement | CIPP | Replacement | CIPP | |
| 8" Replacement / CIPP: | $270.00 | $45.00 | 80.0 | 873.8 | $60,920.66 |
| 8+" - 12" Replacement / CIPP: | $495.00 | $64.00 | 30.0 | 257.2 | $31,313.18 |
| Total Replacement & CIPP Lining: | | | 110.0 | 1,131.0 | $92,233.84 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $38,738.21 |
| **Total Second Priority Replacement & CIPP Lining:** | | | | | **$130,972.05** |
| **Total Estimated Second Priority Sewer:** | | | | | **$3,879,868.47** |
| **Maidens Choice Pressure Sewer Inspection** | | | | | |
| **Item** | **Unit Cost** | | **Quantity** | | **Cost** |
| Dewatering Operations | $50,000.00 | EA | 1.00 | | $50,000.00 |
| Heavy Cleaning Contingent | $10.00 | /LF | 5,100.00 | | $51,000.00 |
| CCTV Inspection | $6.50 | /LF | 5,100.00 | | $33,150.00 |
| Subtotal: | | | | | $134,150.00 |
| Estimated Design, Const. Mngt. / Insp. Etc. (42%): | | | | | $56,343.00 |
| **Total Maidens Choice Pressure Sewer Inspection:** | | | | | **$190,493.00** |
| **Total Estimated First, Second Priority Sewer, and Pressure Sewer Inspection:** | | | | | **$4,972,032.86** |

## Estimated Hydraulic Improvements Budget:

Table 7.4.3 contains the estimated 2008 costs required to complete the hydraulic improvements for each sub-sewershed in the Gwynns Falls Sewershed.

| Table 7.4.3 - Estimated Hydraulic Improvement Budget | | | | | |
|---|---|---|---|---|---|
| Item | Rehabilitation Method | Unit Cost | | Quantity | Cost |
| **Powder Mill Sub-Sewershed** | | | | | |
| 18" Pipe | New | $585.00 | /LF | 276.10 | $161,520.23 |
| 36" Pipe | New | $1,530.00 | /LF | 2,271.00 | $3,474,630.00 |
| Manholes | Rehab / Replace | $3,719.00 | ea | 9 | $33,471.00 |
| Manholes | Sealing | $675.00 | ea | 8 | $5,400.00 |
| | | | | Subtotal: | $3,675,021.23 |
| | | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $1,543,508.92 |
| | | | | **Total:** | **$5,218,530.15** |
| **Forest Park Sub-Sewershed** | | | | | |
| 24" Pipe | New | $1,080.00 | /LF | 1,173.06 | $1,266,906.73 |
| 6" Pipe | CIPP Lining | $45.00 | /LF | 868.70 | $39,091.50 |
| 8" Pipe | CIPP Lining | $45.00 | /LF | 48,537.00 | $2,184,164.87 |
| 10" Pipe | CIPP Lining | $64.00 | /LF | 6,307.07 | $403,652.35 |
| 12" Pipe | CIPP Lining | $64.00 | /LF | 6,309.60 | $403,814.54 |
| 15" Pipe | CIPP Lining | $87.00 | /LF | 3,137.36 | $272,949.96 |
| 18" Pipe | CIPP Lining | $87.00 | /LF | 1,385.96 | $120,578.53 |
| 24" Pipe | CIPP Lining | $124.00 | /LF | 441.28 | $54,718.61 |
| Manholes | Rehab / Replace | $3,719.00 | ea | 324 | $1,204,956.00 |
| Manholes | Sealing | $675.00 | ea | 4 | $2,700.00 |
| | | | | Subtotal: | $5,953,533.10 |
| | | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $2,500,483.90 |
| | | | | **Total:** | **$8,454,017.00** |
| **Dead Run Sub-Sewershed** | | | | | |
| 12" Pipe | New | $495.00 | /LF | 1,219.29 | $603,546.87 |
| 15" Pipe | New | $585.00 | /LF | 2,706.27 | $1,583,168.54 |
| 18" Pipe | New | $585.00 | /LF | 1,252.01 | $732,423.90 |
| 24" Pipe | New | $1,080.00 | /LF | 1,449.14 | $1,565,072.97 |
| 27" Pipe | New | $1,440.00 | /LF | 2,995.85 | $4,314,017.71 |
| Manholes | Rehab / Replace | $3,719.00 | ea | 60 | $223,140.00 |
| Manholes | Sealing | $675.00 | ea | 4 | $2,700.00 |
| | | | | Subtotal: | $9,024,070.00 |
| | | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $3,790,109.40 |
| | | | | **Total:** | **$12,814,179.39** |

| Maidens Choice Sub-Sewershed | | | | | |
|---|---|---|---|---|---|
| 12" Pipe | New | $495.00 | /LF | 644.67 | $319,111.49 |
| 18" Pipe | New | $585.00 | /LF | 111.90 | $65,459.63 |
| 24" Pipe | New | $1,080.00 | /LF | 138.20 | $149,256.00 |
| 36" Pipe | New | $1,530.00 | /LF | 231.59 | $354,338.67 |
| 6" Pipe | CIPP Lining | $45.00 | /LF | 604.80 | $27,216.00 |
| 8" Pipe | CIPP Lining | $45.00 | /LF | 25,769.44 | $1,159,624.71 |
| 10" Pipe | CIPP Lining | $64.00 | /LF | 1,198.08 | $76,676.91 |
| 12" Pipe | CIPP Lining | $64.00 | /LF | 2,682.29 | $171,666.79 |
| 18" Pipe | CIPP Lining | $87.00 | /LF | 2,957.41 | $257,294.79 |
| Equalization Tank | Storage | $6.00 | /Gal | 2,450,000.00 | $14,700,000.00 |
| Manholes | Rehab / Replace | $3,719.00 | ea | 193 | $717,767.00 |
| Manholes | Sealing | $675.00 | ea | 7 | $4,725.00 |
| | | | | Subtotal: | $18,003,136.99 |
| | | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $7,561,317.54 |
| | | | | **Total:** | **$25,564,454.53** |
| | | | | | |
| Item | Rehabilitation Method | Unit Cost | | Quantity | Cost |
| **Gwynns Falls Sub-Sewershed** | | | | | |
| 12" Pipe | New | $495.00 | /LF | 1,280.92 | $634,056.44 |
| 21" Pipe | New | $1,080.00 | /LF | 1,341.18 | $1,448,470.81 |
| 27" Pipe | New | $1,440.00 | /LF | 583.50 | $840,238.97 |
| Manholes | Rehab / Replace | $3,719.00 | ea | 17 | $63,223.00 |
| Manholes | Sealing | $675.00 | ea | 5 | $3,375.00 |
| | | | | Subtotal: | $2,989,364.23 |
| | | | | Estimated Design, Const. Mngt. / Insp. Etc. (42%): | $1,255,532.98 |
| | | | | **Total:** | **$4,244,897.20** |
| | | | | **Total Estimated Hydraulic Improvement Costs:** | **$56,296,078.28** |

The combined total costs associated with completing the First and Second Priority manhole repairs, siphon vault repairs, sewer system repairs, inspection of the Maidens Choice Pressure Sewer, and hydraulic improvements to the conveyance system in the Gwynns Falls Sewershed are estimated to be approximately $61,845,860.

## 7.5 Sewershed Re-Inspection Program

Per the requirements of the CD, the City's Gwynns Falls Sewershed collection system needs to be re-inspected by January 1, 2016. The following sections outline the requirements of the re-inspection program and provide a general schedule for completion of this work.

### 7.5.1 Re-Inspection Prioritization Scheme

The City's condition and criticality protocol provides a framework for a continuous rehabilitation strategy of all collection system components based on both criticality (consequence of failure) and condition (probability of failure). Assets whose failure can have large impacts on the community and the environment and

whose condition is the poorest will receive a higher criticality and condition rating and will receive attention in a more timely manner. Assets that receive a lower criticality and condition rating will receive some level of continued monitoring as recommended herein but no immediate action or rehabilitation. Refer to Section 7.1 Decision Making Criteria for details. The following sections detail the requirements of future inspection programs.

### 7.5.2 CCTV and Manhole Inspections

The implementation schedule provided includes provisions for the re-inspection of each of the sub-sewershed collection system components by January 1, 2016. The proposed re-inspection schedule includes provisions for, but is not necessarily limited to, a prioritization scheme for further inspection of collection system components based on the following criteria:

1. Prior identification of system defects, prior NASSCO PACP or MACP rating codes, grease blockages, root intrusion or system complaint data.
2. Prior criticality and condition ratings.
3. Expected life cycle of system components.
4. Estimated rate of existing or potential inflow and/or infiltration.
5. Scheduled rehabilitation or other corrective action of a system component; and the predetermined re-inspection frequency of a collection system component.

Current sewershed studies are scheduled to be completed by July 2010. Following these studies, the City intends to implement a continuous CCTV and manhole inspection program aimed at re-inspecting all gravity sewers 8-inches in diameter and larger, and all force mains, pumping stations, manholes and other sewer structures by January 1, 2016. The planned re-inspection activities will be prioritized based on the condition and criticality factors determined during this project.

The implementation schedule for re-inspection of these sewershed system components is outlined in Table 7.5.1:

**Table 7.5.1 - Sewershed Re-Inspection Implementation Schedule**

| Task | Duration (Mos.) | Start Date | End Date | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| **Manhole Inspections** | 24 | 5/1/2013 | 5/1/2015 | | | | | | 1-Jan-16 |
| Analysis and Report | 30 | 6/1/2013 | 12/1/2015 | | | | | | |
| | | | | | | | | | |
| **Pumping Station Insp.** | 6 | 5/1/2015 | 11/1/2015 | | | | | | |
| Analysis and Report | 6 | 6/1/2015 | 12/1/2015 | | | | | | |
| | | | | | | | | | |
| **Force Main Inspections** | 6 | 5/1/2015 | 11/1/2015 | | | | | | |
| Analysis and Report | 6 | 6/1/2015 | 12/1/2015 | | | | | | |
| | | | | | | | | | |
| **Sewer Inspections** | 24 | 5/1/2013 | 5/1/2015 | | | | | | |
| Analysis and Report | 30 | 6/1/2013 | 12/1/2015 | | | | | | |

Based on the condition of the assets observed during this study, manholes and sewers that received higher condition and criticality rating scores were recommended for inclusion on the First and Second Priority corrective action plan. Once rehabilitated, these manholes and sewers can be placed on a “Low Priority” inspection program with regular inspections occurring once every 5 to 10

years. The manholes and sewers that received condition ratings of 3 were classified as requiring "Frequent Assessment" under the condition and criticality rating system, and can be inspected on regular 2-3 year inspection intervals to insure the continuity of the collection system. Manholes and sewer segments that are currently in serviceable condition but received higher criticality ratings were identified as requiring "Regular Monitoring" can be inspected every 3-5 years. Based on the results of those inspections, any manholes and/or sewers that have continued to deteriorate to a point that requires repair should be repaired on an as-needed basis to address specific problems or deficiencies that have occurred.

## 7.6 Future Data Collection and Evaluation Services

As required by the CD, under Paragraph 9-C-xii, the City will be required to implement several continuous data collection programs in order to assess the effectiveness of the rehabilitation programs and other O&M enhancement efforts within the sewershed. These programs will be comprehensive, system-wide initiatives that will include a long-term flow monitoring plan, a sewer cleaning program, CCTV and manhole inspection programs and root control and grease control programs. These are discussed in greater detail in the following sections.

### 7.6.1 Long-Term Flow Monitoring Plan

In 2006, under Project 935, the City of Baltimore implemented a comprehensive flow monitoring program for the purpose of evaluating the severity of infiltration and inflow and for calibration of the hydraulic model. This comprehensive program consisted of a network of about 350 flow meters, 20 rain gauges, and 33 groundwater monitoring stations, and extended for a period of one year from May 2006 through May 2007. In May 2007, the network was reduced to about 100 flow meters that were placed at key points and junctions in the collection system for the purpose of long term assessment and continuous calibration of the hydraulic model. All 20 rain gauges remained in operation. The City plans to continue monitoring the flows in order to assess the effectiveness of the on-going and future rehabilitation and O&M enhancement programs.

### 7.6.2 Sewer Cleaning Program

The effectiveness of a sewer conveyance system is largely dependent on its ability to convey the flows generated within the sewer basin without surcharging the system to a point where overflows occur. As part of the sewer inspection program completed for this study, all sewers that were inspected were also cleaned. The intent was to clean the sewer so the inspections could identify defects that otherwise would not be visible during the inspection and to remove debris from the sewer to restore the sewer to at least 95% of its original carrying capacity. When significant restrictions such as roots or other debris was encountered, heavy cleaning was utilized to restore the capacity of the sewers and allow for internal inspection. Heavy cleaning involved root cutting, grease removal, and/or additional passes of the hydro-cleaning equipment to remove heavy accumulations of sediment and debris. All debris was removed from the sewers and disposed of at an approved disposal site.

Based on the cleaning work completed during this project and observations from the completed inspection work, URS recommends that sewers which contain heavy accumulations of grease, debris and/or roots, large interceptor sewers, sewer siphons, and sewers be cleaned on a regular basis to maintain adequate hydraulic capacity. These cleaning operations should be closely coordinated with the sewer re-inspection program, which must be completed by January 1, 2016, and prioritized based on condition and criticality rating factors that were determined during the inspections described in Section 7.1. Under normal operating conditions, the remaining sewers should require less frequent cleaning.

### 7.6.3 CCTV and Manhole Inspection Programs

The City also intends to implement continuous citywide CCTV and manhole inspection programs following the completion of the CD sewershed studies, which are scheduled to be completed between June 2009 and July 2010. These programs will be aimed at re-inspecting all gravity sewers 8-inches and larger in diameter, force mains, pumping stations, manholes, and other sewer structures by January 1, 2016. The planned re-inspection activities will be prioritized based on each segment's condition and criticality ratings that were derived during the sewershed inspections described in Section 7.1 of this report.

In accordance with City guidelines, all PACP condition grade 1 and 2 sewers in the Gwynns Falls Sewershed should be re-inspected in a 5 to 10 year period range. All PACP condition grade 3 sewers should be re-inspected in 2 to 3 years to reassess their condition and assign appropriate repairs as needed.

### 7.6.4 Root Control Program

In 2004, under Project 1015, the City began monitoring the impacts of root infestation in their collection system by tracking and geocoding customer calls related to root problems in the sewer. In 2006, the City identified an area in the Gwynns Falls Sewershed as having severe root intrusion problems (approximately 1,500 acres, 69,186-lf of pipe). The City proceeded to implement a root control chemical application pilot project in this area in 2007, which included the treatment of approximately 150 house laterals and service connections. The pilot project yielded promising results. The City is therefore expanding the Root Control Program (RCP) into other areas of the collection system with documented root intrusion problems. A recent evaluation of customer calls in 2007 identified two additional areas with severe root infestation (see Figure 7.6.1).

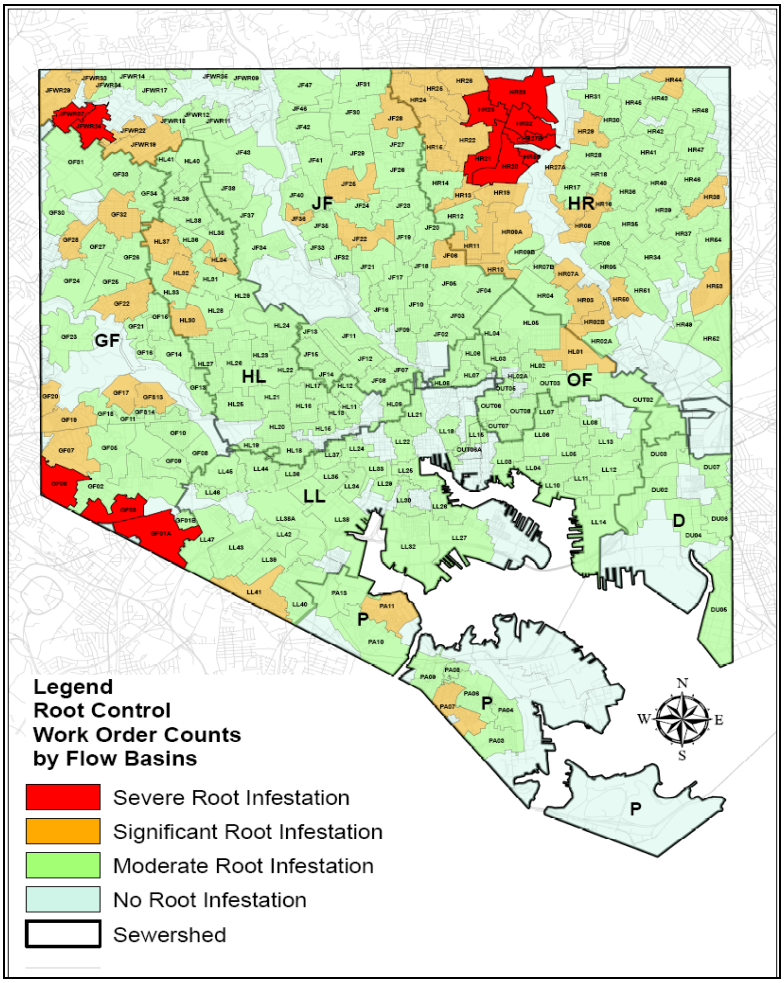


**Figure 7.6.1 – Root Control Analysis**

To evaluate the effectiveness of the on-going root control program, the Project 1015 Technical Manager will use other sources of information, such as CCTV and manhole inspections, to validate and direct the root control efforts. The goal of the on-going RCP is to treat all areas of the collection system experiencing root infestation once every three to five years. The effectiveness of the RCP will be assessed by continued monitoring of the areas and ongoing evaluation of customer complaint calls within these areas on a six month review basis.

### 7.6.5 Fats, Oils and Grease Control Programs

Similar to root infestation in the sewer system, the City, under Project 1015, began assessing the impacts of Fats, Oils and Grease (FOG) in the collection system in 2004. The City geocoded and mapped all customer complaint calls related to FOG and identified five sections of the collection system where severe problems exist. Unsurprisingly, these sections serve areas with numerous restaurants and/or food establishments, namely Little Italy and the Johns Hopkins Hospital area - where many restaurants serve the hospital community - and the upper reaches of the High Level Sewershed, which have numerous restaurants and a large mall with a food court. The City proceeded to outfit two

of its newest sewer vac-trucks with de-greasing equipment and began treating the targeted areas in 2006. These areas are currently on a regular cleaning schedule and are addressed twice a year for grease. The City will continue to evaluate customer complaint calls and utilize CCTV and manhole inspection data in order to assess and guide future activities of the FOG Program.

### 7.6.6 Re-Inspection Prioritization Scheme

The condition and criticality protocol provides a framework for a continuous rehabilitation strategy of all collection system components based on both criticality (consequence of failure) and condition (probability of failure). Assets whose failure may have large impacts on the community and/or the environment and whose condition is the poorest will be made a priority and receive attention sooner. Refer to Section 7.1 Decision Making Criteria – Condition and Criticality Assessment for details.